



Structure and Evolution of the Universe Subcommittee
Inn and Conference Center, University of Maryland
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Balloon Program Update

Part 1: Plans for Input to the OSS Strategic Plan
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Part 2: Plans for the ULDB Program Recovery
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Mission of the Balloon Program

The Balloon Program Seeks to be a Springboard for Space Science by
Providing Low-cost Access to Space at altitudes up to 160,000 ft for:

Niche Science Investigations that can be done above ~ 99.5% of the Atmosphere

Observatory-class Payloads With Advanced Technologies and Large Aperture/Mass

Technology Development and Flight Validation for Future Space Missions

Cutting edge science in 10 - 20 day missions, with plans for 60 - 100 days flights as
alternative to Shuttle or ELV launches

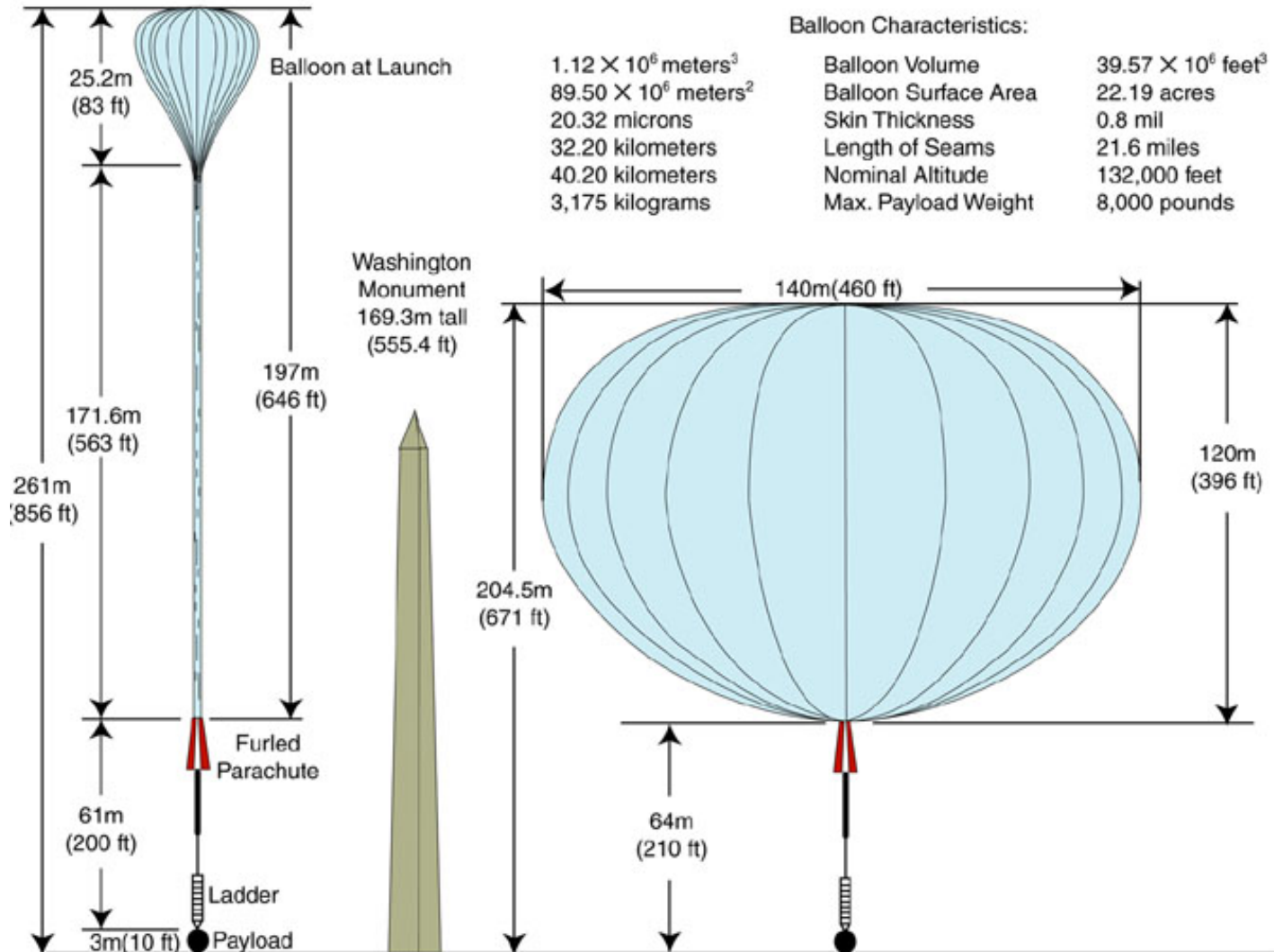
Hands-on Training of Students and Young Scientists

- Average ~ 25 missions/year
- Involves ~ 40 University and Center groups,
- ~ 200 Scientists and Engineers,
- ~ 25 Graduate Students, ~ 50 Undergraduate Students,
- Substantial Foreign Involvement at ~25% of OSS level

Science Payloads Are Solicited in the Annual ROSS NRA's (SR&T/R&A), and they
are Funded by Grants

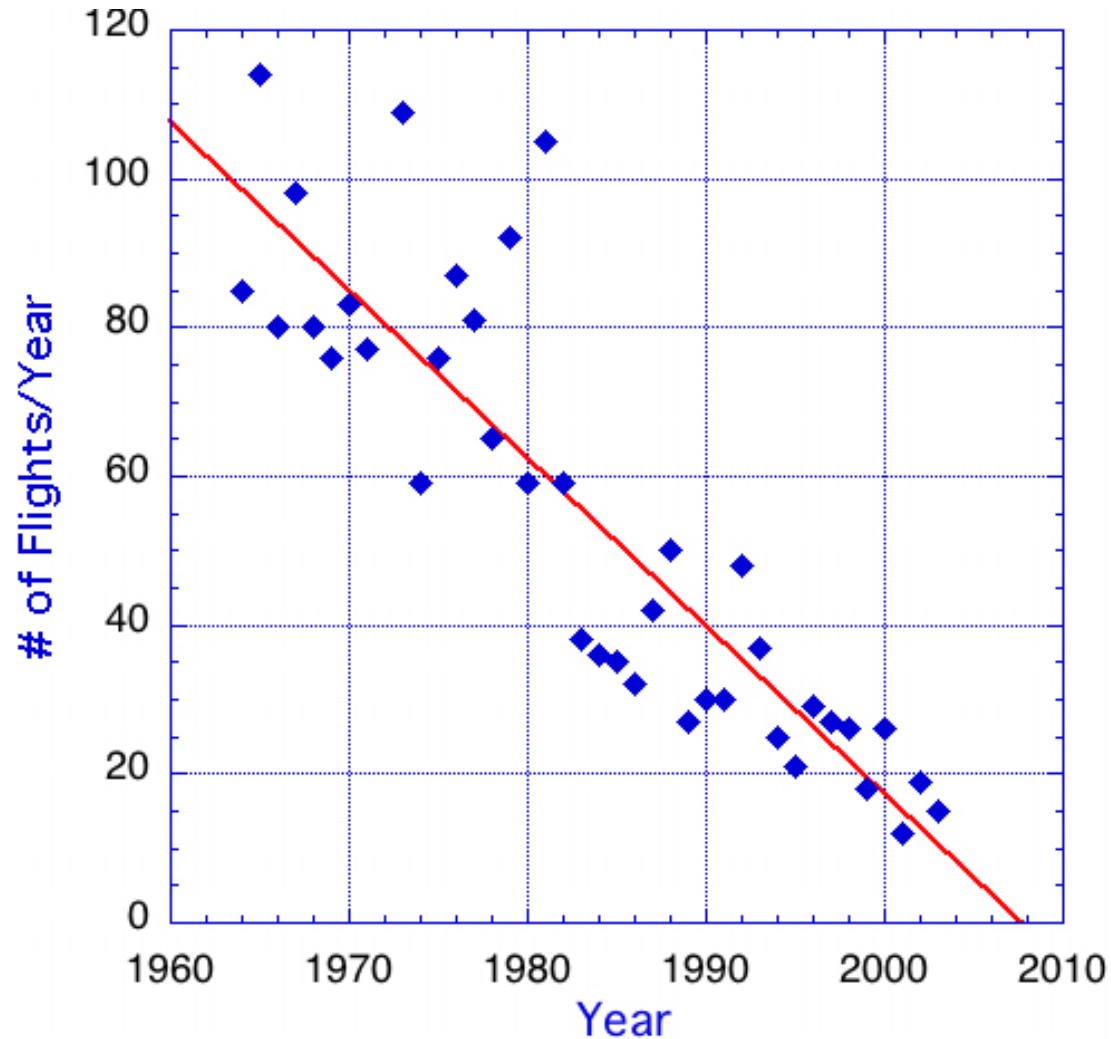


Balloons



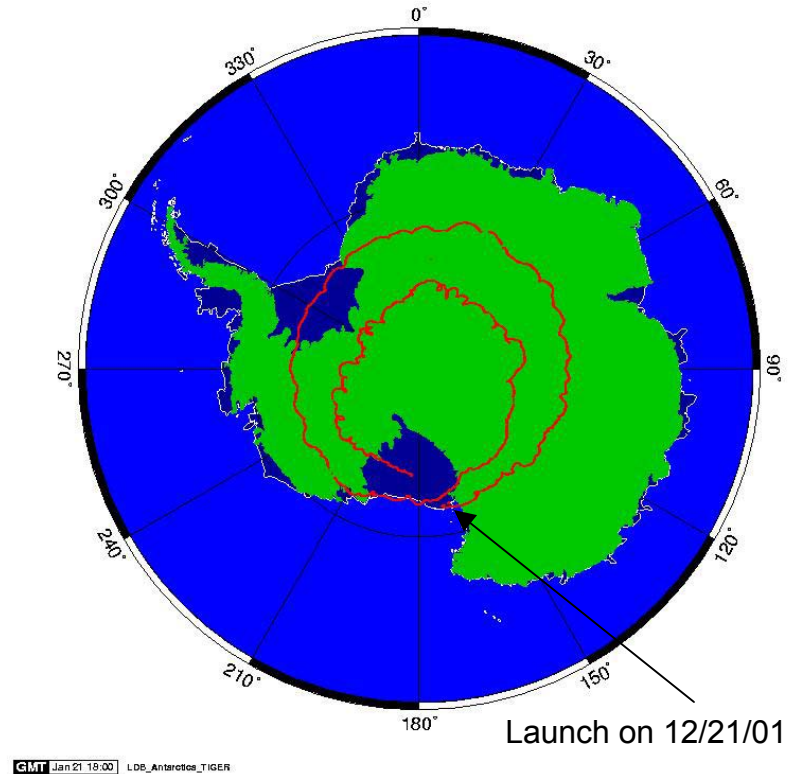


We Must Increase the Flight Rate!





As the Number of Flights Decreased, the Flight Durations Increased



Trans-Iron Galactic Element Recorder (TIGER) : A record setting 32 day flight in FY 2002 and 17-day reflight in FY 2004



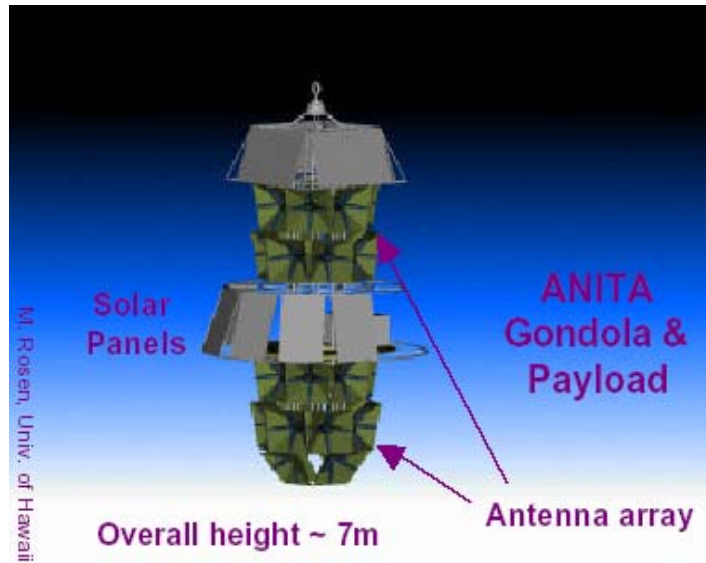
Antarctic Balloon Flights FY 1990 - FY 2004

FISCAL YEAR	PRINCIPAL SCIENTIST	DATE LAUNCHED	DATE TERMINATED	FLIGHT HOURS	FLIGHT DAYS	SUSPENDED (LB)	SCIENCE (LB)
FY90	LIN/WESTPHAL	01/01/90	01/01/90	0.13	0.01	3611	2570
	LIN	01/08/90	01/08/90	3	0.13	2590	1380
FY91	LIN/SESTPHAL	12/20/90	12/29/90	209	8.71	3750	2150
FY92	SALAMON	12/16/91	12/26/91	219	9.13	3750	2589
	LIN	1/10/92	1/22/92	329	13.71	3750	2850
FY93	TROMBKA	12/12/92	12/26/92	324	13.50	4559	3710
	LIN	12/31/92	1/10/93	2/259	10.79	4164	3600
FY94	WILKES	12/14/93	12/24/93	227	9.46	4236	3007
	WILKES	1/2/94	1/10/94	214	8.92	4537	3015
FY95	WILKES	12/21/94	1/3/95	305	12.71	4576	2940
	LIN	1/8/95	1/95	574.8	23.95	4750	3340
FY96	WILKES	12/19/95	1/2/96	348	14.50	4586	2950
	RUST	1/7/96	1/26/96	460.83	19.20	4763	3170
FY98	LIN	1/7/98	1/11/98	99	4.13	4809	3130
FY99	LANGE	12/29/98	1/8/99	254	10.58	4739	3650
FY00	RUST	1/10/00	1/27/00	409	17.04	4825	3300
	LIN	1/11/00	1/30/00	450	18.75	3875	2314
FY01	WEFEL	12/28/00	1/13/01	384	16.00	4935	3470
	CHENG	1/4/01	1/31/01	644	26.80	4071	2934
FY02	BINNS	12/20/01	1/21/02	764.3	31.85	3566	2325
FY03	WEFEL	12/30/02	1/17/03	477.6	19.9	4927	3845
	RUHL	1/6/03	1/21/03	361.72	15.07	4753	3650
FY04	BINNS/GORHAM (*)	12/17/03	1/4/04	443	18.46	4707	2420
	MUELLER (*)	12/12/03	12/26/03	368	15.29	5966	3550

(*) 40 MCF balloons were introduced in FY 04: Two could be in the air simultaneously starting in FY00 flights



First Balloon Explorer Phase A Study (SMEX Mission of Opportunity) Antarctic Impulsive Transient Antenna (ANITA), Peter Gorham (U. Hawaii)



Opens a new observational window into astrophysical sources that would complement photon-based measurements.

A Null result would indicate a breakdown in understanding of particle physics or significantly smaller UHE proton flux.

Identifies UHE neutrinos by detecting RF signals emitted when neutrinos interact in Antarctic ice shelf.

Achieves enormous effective areas (10^6 km^2) by flying a multi-element pulse-phased radio frequency antenna on balloon around Antarctica.



The Program is Again at a Crossroad

The Antarctic LDB Program was Proposed after the Challenger Accident

- It was intended to help offset the loss of Shuttle/Spacelab
- It followed NASA's "Famous Forty" cancellations and the decision to restrict use of the Shuttle for the Observing Sciences

Changes since the Columbia Accident Justify a New Plan for Balloons

- The Shuttle is scheduled to be retired after ISS-Complete about 2010
- NASA recently restricted use of the ISS for the physical sciences

LDB and/or ULDB missions can help maintain the SEU workforce

- Conduct niche science, develop new technology, and train young scientists while waiting for delayed top-priority SEU missions

"Big 60" flights at 160,000 ft enable Soft X-Ray & UV measurements

Focus a Strategic Balloon Plan on Both Payloads and Operations

- Increase the Number of Conventional and LDB Flights
- Complete the Development and Demonstration of ULDB



What Limits the Number of Flights in Antarctica?

Budget from NASA/Office of Space Science not Robust Enough to Support all the Payloads, Operations, New Technology and Facilities

Inadequate Logistics Support from NSF/Office of Polar Programs for More than 2 flights per Year

Inherent Limitation of the Austral Summer Length

Some Self-Imposed Limitations due to our Operations Policy

The Need to Recover Balloon Carcasses to Meet EPA Constraints for Keeping the Antarctic Continent Pristine



Additional Resources are Needed from NASA/OSS

It Seems as if Everybody Loves Balloons, but they are Usually Just Below the Cutoff in Priority Lists

Budget Situation

- The budget for payloads has not kept up with cost of technology
- The number of funded payloads barely sustains the operations
- The operations budget barely sustains the program
- NSF/OPP is pushing for full cost accounting & recovery
 - We are using a “loan” to construct the new launch facilities
- There has been minimal additional funding for the ULDB vehicle

Balloons are NASA's Cinderella: Is the Strategic Plan a Ticket to the Ball!

- A modest budget line could double/triple the LDB flight rate
- One competitively selected LDB/ULDB mission could start each year
- Reflights would result in additional LDB/ULDB flights each year
- This would more than double the science output of balloons



We Need More Logistics Support from NSF/OPP

A New MOA Was Signed with NSF/OPP in August 2003

- It updates the 1988 MOU to cover the historical reality
- A sunset clause requires a new MOA prior to March 2009
- It calls for NASA to rebuild the LDB facilities in McMurdo

NASA will be Charged for Facilities & Services Previously Paid by NSF

- New power generators in FY 2003
- New LDB launch facilities in FY 2004; and all future upgrades
- Scientists travel costs to New Zealand
- Air shipments for equipment arriving late in Port Hueneme
- Logistics costs (~\$500k) for flights in excess of two per season



Some Operation Changes Are Needed

Resources Needed to Improve the Recovery Process

- An additional aircraft dedicated to payload recovery
 - Twin Otters must ferry people & equipment from field camps
- Land-Traversal recovery for payloads landing on the Ross Ice Shelf
 - Payloads would be recovered fully intact

Current Environmental Impact Statement (EIS) supports 1988 MOU

- Expected maximum of 1 - 2 Flights per year
- Best efforts are made to recover parachutes & all payload hardware
- Balloon carcasses are currently left on the Ice

Will need to update the EIS if the flight rate increases substantially

- Balloon Carcasses should be recovered
 - Some additional resources will be needed
 - ~ 12 acres of thin polyethylene film per carcass



Procedural Changes Could Increase Efficiency

Could Use a Hybrid Balloon Flight & Space Flight approach

- If recovery is not required for follow-on science flight:
 - Let them Fly Till They Die!
- Might get 45-day flights for the price of 10-day flights
 - Would reduce the scientific need for multiple flights

If an Investigation Requires >1 Flight, Building a Duplicate Payload May be Cheaper than Conducting a Duplicate Flight(s)

- Full cost could be less, but burden would transfer to scientist

Consecutive Use of Payload Integration Buildings on the Ice Could Double the Payload Accommodations

- Use Christchurch as standby base for “Fly and Launch” approach
- Have a second payload in waiting at Christchurch
- When first payload is launched, move second payload to McMurdo



Ways to Mitigate Limitation of the Austral Summer

Develop Routine Capability to double/triple the Number of LDB Flights

- If the will exists and resources are available, we could have this capability in place for the next MOA with NSF in 2008

Create Comparable Capability in the Northern Hemisphere

- Continue seeking the over flight agreement with Russia
- Or, give up on Russia and:
 - Conduct flights from Sweden to Canada
 - Conduct flights from Brazil to Australia

Develop super-pressure balloons to fly at mid-latitudes, including modest trajectory control to mitigate safety concerns

- Conduct LDB flights at mid-latitudes: e.g., Australia to Australia
- Conduct ULDB flights from Antarctica and/or Australia



Strategic Planning Process

The Project Scientist is Accumulating Statistics & Record of Past Contributions

- A GSFC Science writer is drafting text for a White Paper

The Balloon Program Office at WFF is Preparing a Strategic Operations Plan

A NASA-NSF/OPP Workshop on Antarctic Ballooning is Planned for May 2004

- Objective is to develop NSF/OPP plan for next 5-years, and out-years
- Will follow the Antarctic Cosmology and Astrophysics Workshop
- NSF/OPP suggests attendance by invitation only: Space limited to 40 people
- Each user Discipline Scientist will be allowed to invite ~ 2 scientists
- Both NASA and NSF/OPP operations people will be invited

A Balloon Planning Group will be Established Soon to Report to SEUS

- Membership will include representatives of the above participants
- Balloon Working Group and select users will be asked to review the report
- Teleconferences will be held as needed: at least one face-to-face meeting
- Town Hall meetings will be held in conjunction with scientific conferences



Scientific Balloon User Disciplines

IR/Submm

- Cosmic Microwave Background
- Infrared and Sub-mm Astronomy

High Energy Astrophysics

- Gamma Rays & Hard X-Rays

Particle Astrophysics

- Anti-particles/Dark Matter Search
- Cosmic Ray Spectra and Composition

High Energy Neutrino Astronomy

- Antarctic Impulsive Transient Antenna

Solar and Heliospheric Physics

Geospace Sciences

UV and Soft X-Ray Astronomy

Other Non-OSS Disciplines

- Upper Atmosphere, Radiation Shielding, etc.



Part 2

Plans for the ULDB Program Recovery

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ULDB Balloon Vehicle Development

Corrections Underway

3/16/03 Test Flight From Alice Springs Failed To Properly Deploy And Failed To Maintain Pressure, Thus Terminated Early

Anomaly Review Board Identified Clefting (Fail To Fully Deploy) As Probable Cause, Creating Localized Stresses That Breached Shell

- Clefting caused by excess material near apex & bottom to mitigate risk of meridional stresses caused by foreshortening of tendons

FIX: Design & Fabrication Process that Loads Tendon To Remove Stretch While Encapsulating Tendon in Balloon Tape Seal (Similar To ZPB Load Tapes) Fabricated into Balloon During Gore Sealing Runs

- Eliminates need for added gore meridional material / no foreshortening

Secondary Concerns As To Possible Damage During Inflation

- Current approach eliminates foreshortening
 - Reduces unevenness of stack reduces localized spool contact pressures
 - Less excess material minimizes damage while deploying out of the stack
- Softening of spool with ~2 inch rubber sleeve further mitigates localized contact pressures from unevenness in the stack



ULDB Vehicle Development Plan

2 MCF Size Test Flights Throughout FY04 (4 - 5); Circumglobal 4 MCF Southern Hemisphere Test Flight Dec 04; Full Scale Circumglobal Southern Hemisphere Qualification Test Flight Dec 05

- Cylinder tests & small model tests
- Performance model upgrades
- Manufacturing improvements
- ULDB Sensor Package
- Materials characterization & improvements

Contingency Endeavors

- Alternate launch technique development underway (NSBF)
- Alternate independent design study underway (CSC/SWALES/GSSL/ILC Dover)
 - Design for minimum risk while maximizing to achieve requirements

Focus On Models

- TENSYS Inc. – Finite Element Model
- GSFC/AETD – Scaling

Other Ongoing Studies To Mitigate Clefting

- Circumferential cord to limit gore expansion to designed width (cord length)
 - Clefting “stretches” adjacent gores
 - Cord facilitates forcing-out cleft



Antarctica Balloon Operations

New NASA/NSF MOA is Valid Through March 2009

Project Initiation Conferences to be held 1 Yr Prior to Each Campaign

- Assess mission requirements & select primary and alternate payloads
- Develop formal *Annual Implementation Plan* for each campaign
 - Roles and responsibilities of each agency for each campaign
 - Unique support requirements
 - Follow-up review at end of 1st quarter of calendar year of planned campaign to update information required to finalize *Annual Implementation Plan*

MOA Baseline is Two Launches per Year From Antarctica

- Consistent with previous level of activity supported by NASA & NSF
- Redesign of support concept & facilities may allow additional launches without significant increase in operational impact
 - Number of launches may be increased at future date upon mutual agreement between NSF and NASA through the *Annual Implementation Plan*



Antarctica Balloon Facilities

New Facilities Definition / Design Project Underway

- Being worked by team from Raytheon Polar Services Corporation and National Scientific Balloon Facility
- Review and approval by NSF and NASA
- 30% design review by end of March '04
 - Priority on long-lead items: Pre-fab building shell / Skid floor structure
- Funding approval to proceed – April '04
- Final design July '04
- Procurement complete / final shipment materials – October '04
- Built / ready to occupy – October '05

Two-Payload Support Capability (Perhaps 3rd Depending on Cost)

Concept:

- Flight readiness preparations and launch at Williams Field
- Line-of-sight monitoring at Williams Field (~1st 16 hours after launch)
- Over-the-horizon TM monitoring station in town (McMurdo) and at NSBF in Palestine, Texas



Upgraded Antarctica Balloon Launch Capability

New NSBF Challenger “Boss” Launch Vehicle Capable of Handling Gross Inflations of Largest Standard NASA Balloon (37 MCF Heavy Lift – 8000 lb Suspended)

Used To Launch Both TRACER & TIGER / ANITA-Lite Missions During Past FY04 LDB Antarctica Campaign. Both Flown Using 40 MCF Lite Balloons – 6000 lb Suspended.

